Ultrafast all-optical control in photonic crystal cavities using nonlinear absorption

C.-S. Kee*, Y. L. Lee, D.-K. Ko, and J. Lee
Advanced Photonics Research Institute, Gwangju Institute of Science and Technology, Gwangju 500-712, Republic of Korea
H.-G. Choi, J.-E. Kim, and H. Y. Park
Department of Physics, Korea Advanced Institute of Science and Technology, Daejon 305-701, Republic of Korea

Optical nonlinearities of semiconductors can offer interesting effects on the properties of photonic crystals based on semiconductors [1]. In particular, the nonlinear absorption such as two-photon absorption can give an opportunity to control optically the properties of semiconductor photonic crystals. Moreover, a fast response time of free carriers generated by two-photon absorption can offer rapid control in semiconductor photonic crystals. Thus the nonlinear absorption can be useful for achieving ultrafast all-optical control in photonic crystal devices. In this presentation, we theoretically show that the properties of AlGaAs photonic crystal cavity can be optically controlled by two-photon absorption. The measured free carrier induced refractive index change as a function of pump power [2] was employed in the calculations. The resonant wavelength λ_{re} exhibits a blueshift when the pump power increases. The modulation depth, defined as $| (T_{\text{pump-off}} - T_{\text{pump-on}}) / T_{\text{pump-off}} |$, can reach about 90 % when the pump power is 2.5 mJ/cm^2. The modulation time is predicted to be faster than 10 ps.

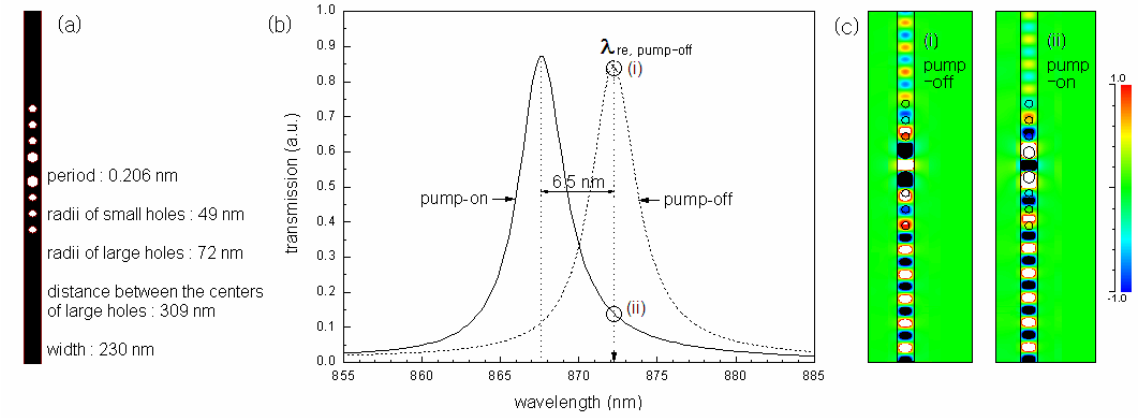

Figure 1. Transmission spectra for TM mode whose magnetic field is parallel to the axis of a hole through AlGaAs photonic crystal cavity (a) and spatial distributions of magnetic filed for $\lambda_{re,\ \text{pump-off}}$ when the pump laser with power of 2.5 mJ/cm^2 is off and on (b). Schematic top view of AlGaAs photonic crystal cavity and its structural parameters are shown in (c).

Reference

*Email: cskee@gist.ac.kr

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